

REMARKS

Claims 1 to 3 were rejected under 35 U.S.C. 103 (a) as obvious over U.S. Patent Publication 2003/0174300, of K. Endo, et al.

Admittedly optical inhomogeneities (aberration from the wave front) in classical quartz and glass lenses have been determined with known methods. However in these different materials the inhomogeneity is normally symmetrical in a given volume. However the present invention relates to crystalline material that has linear and two-dimensional defects in a plane and not to areal or volumetric defects that occur in the above-described quartz material.

In the crystalline material of the present invention the defects are e. g. small angle boundaries and slip planes (see page 3, first full paragraph, of applicants' specification). These defects are linear (one-dimensional) or even planar (two-dimensional).

The purpose of the presently claimed process according to applicants' claims 1 to 3 is to identify those lens blanks having defects that cannot be healed by a tempering or annealing process. The invention provides a method of avoiding an expensive

tempering process that consumes time and energy for those blanks which cannot be effectively healed by the tempering process.

In order to do that according to the present invention a wave front image is measured with an interferometer and the measured wave front is fit to a Zernicke polynomial expansion. Line scans of the larger defects are performed across the individual defects. A fitting process is performed to find the Gaussian curve that mathematically fits a peak corresponding to an individual defect in the line scan best, but only after subtracting the first 36 Zernike terms (see the fourth paragraph on page 5 of the applicants' U.S. specification). Thereafter the area under that curve (function) is determined by multiplying the peak height and the half-width of the peak corresponding to the defect, and then further multiplying the result by the length of the defect to obtain an integral value. The integral value is characteristic of whether or not the defect can be healed or not.

Applicants further find that most small angle grain boundaries cannot be healed, whereas slip planes can be healed almost completely by tempering (see page 7 of applicants' U.S. specification). Accordingly if too much and too large non-healable small angel boundaries are found, then further tempering of that lens blank is not performed and it is discarded or used for other purposes.

If only slip planes are determined to be present by the process of applicants' claims 1 to 3, then one knows that one should continue to temper the lens blank because a good quality lens can be made from it (page 9, paragraph 2, of applicants' U.S. specification and also see page 3, lines 6 to 12). Also the value of the integral corresponding to the defect is a measure of the temperature at which the tempering should be performed.

Endo describes a method of evaluating refractive index homogeneity for optical elements used in photolithography. In the method according to claim 1 of Endo the wave front aberration of light of a given wavelength that is transmitted through an optical element is measured. Then the measured wave front aberration is fit in a Zernike fitting step. Thereafter individual components of the polynomial are separated into a rotational symmetric part, an odd-symmetric part, and an even symmetric part, and then element and thereafter the individual components are separated into a plurality of further parts according to a degree thereof.

Preferably the individual components of the polynomial are separated into three parts of lower, middle, or higher order (claim 2 of Endo). The lower, middle, and higher order terms have $n = 4$ to 8 , $n = 9$ to 35 , and $n > 35$ respectively (claim 3 of Endo).

Paragraph [0139] of Endo is cited in the Office Action for

suggesting subtracting the first 36 Zernike terms to determine the aberration and for teaching determining an RMS value for the “higher order” terms.

However paragraph [0218] of Endo states that only the first 36 terms Zernike coefficients are obtained by a least squares fit to the measured results in Table I. Paragraph [0130] states that the Zernike functions with $n = 36$ or greater are not used in the fitting process. According to the example illustrated in fig. 2 a Zernike fitting takes place with the terms $n = 0$ to 80 and the example illustrated in fig. 3 involves a Zernike fitting with terms 0 to 36. Paragraph [0091] teaches that fitting is only possible for a limited number of coefficients as a practical matter due to the heavy burden involved in performing the calculations, e.g. up to the 10^{th} order when $n = 0$ to 35.

Thus the Endo does not appear to clearly teach a fitting that is performed with a Zernicke function after subtracting the first 36 Zernike terms. However Endo does teach separating a Zernicke function into various terms including lower order terms, middle order terms and higher order terms

Furthermore, as admitted in the Office Action, Endo is silent regarding performing a line scan of the larger defects and fitting the results to a Gaussian function to obtain an integral value of the area under the curve, which is used as characteristic parameter to

identify the type of defect.

Applicants' have found that improved results are obtained when the first 36 terms of the Zernike polynomial are subtracted prior to fitting as explained in connection with their figure 1 in the fourth paragraph on page 5 of their originally filed specification.

Furthermore as can be understood from the disclosures in Endo, et al, their method is applied to a so-called quartz glass, which is also used as a material for optical elements in photolithography. Quartz glasses are not crystalline and their behavior is completely different from the crystalline fluorides of the above-identified method, especially calcium fluoride.

Furthermore the method claimed in applicants' claims 1 to 3 enables assignment of local defects or local inhomogeneities to a distinct defect type because of the elimination of the first 36 Zernike terms and generating a fit curve to the respective line scan (first line scan depleted of those terms), determining the peak height and half width of the fit curve, multiplying the peak height and half width together and then further multiplying by the length to obtain an integral value.

The integration over a Gaussian curve fit to individual defect structures in the wave front is not disclosed or suggested in Endo.

Specifically, as admitted in the second paragraph on page 3 of the Office Action, Endo does not disclose or suggest performing line scans over the length of the larger defects and fitting the results of the line scan to a Gaussian curve that mathematically fits a peak corresponding to an individual defect in the line scan best. Endo does not disclose or suggest multiplying the peak height and the half-width of the peak corresponding to the defect, and then further multiplying the result by the length of the defect to obtain an integral value that is characteristic of whether or not the defect can be healed or not.

The aforesaid features provide a convenient method for classifying defect structures and using the results for the integral values to evaluate crystalline blanks to determine whether or not an optical element can be produced that is satisfactory for photolithography.

This sort of convenient defect categorizing scheme is not disclosed or suggested in Endo. Endo only teaches a general method of fitting wave front aberration measurements to Zernicke polynomials and separating the results into groups of terms for evaluation.

For the aforesaid reasons, withdrawal of the rejection of claims 1 to 3 under 35 U.S.C. 103 (a) as obvious over U.S. Patent

Publication 2003/0174300, of K. Endo, et al, is respectfully requested.

Should the Examiner require or consider it advisable that the specification, claims and/or drawing be further amended or corrected in formal respects to put this case in condition for final allowance, then it is requested that such amendments or corrections be carried out by Examiner's Amendment and the case passed to issue. Alternatively, should the Examiner feel that a personal discussion might be helpful in advancing the case to allowance the Examiner is invited to telephone the undersigned at 1-631-549-4700.

In view of the foregoing, favorable allowance is respectfully solicited.

Respectfully submitted,
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